

REMARKS

New claims 12 to 17 are supported by pages 7 and 8 of the specification.

The objections to the claims have been overcome by amending the claims in the manner suggested in the objections.

The rejection of claims 1, 4 and 5 regarding indefiniteness has been addressed by amending claims 1 and 5 to avoid the term “sufficiently small” and by canceling claim 4.

The rejection of claims 1 to 11 as reciting non-statutory subject matter is traversed. The claimed invention does produce a useful, concrete and tangible result. The results generated by the claimed invention are estimates of spectrum of endmembers of multispectral data values and estimates of mixing proportions of each endmember in each data value. These estimates of spectra of endmembers and mixing proportions are used in subsequent analysis steps to determine the nature and composition of the multispectral data or the subject represented by the multispectral data values. The estimates are tangible because they are actual discrete spectral values and mixing proportion values. The estimates of endmembers and mixing proportions are concrete because they are results of repeatable processes. For example, where the multispectral image is obtained from an airborne or satellite image of an area of land, the endmember spectra can be used to determine the pure spectral constituents of each image element (pixel) and the proportions are the amounts of each pure endmember spectrum in each pixel. These values of endmember spectral values and mixing proportion values can then in turn be used to determine the composition of the image. For example, various minerals have a

characteristic spectral signature, thus determined endmember spectra and mixing proportions can be compared against known signatures to determine whether and where the various minerals are present in the image. The endmember spectral values can be used to determine whether and where a particular mineral is present in the image, which is of practical utility in mineral prospecting by remote sensing. It is therefore clear that the result is useful, it is repeatable and predicable and therefore concrete and tangible.

The rejection of claims 1 to 4 and 7 to 11 as being anticipated by Keshava has been overcome by amendment and is traversed. Claim 1 has been amended and the amendments are supported on page 7 of the application.

The method of independent claim 1 includes steps for estimating the spectrum for endmembers and the mixing proportions of spectra of endmembers, has a term which is a measure of the size of the simplex that is based on a regularized residual sum of squares. The method recited in claim 1 is not anticipated and would not have been obvious because: (1) the methods referenced on page 54 right column of Keshava (which are applied to support the rejection) assume that endmembers are known or have been previously estimated, (2) the other methods disclosed in Keshava do not add a term which is a measure of the size of the simplex to the residual sum of squares, and (3) the measure of the size of the simplex being the sum of the squared distances between all of the simplex vertices is not disclosed in Keshava to regularize the residual sum of squares.

Keshava makes no mention of minimizing the error in the estimates (regularized residual sum of squares) by including a term which is a measure of the size of the

simplex. Pages 52-54 of Keshava explain that there are essentially three methods of automated endmember determination, namely Non-parametric Methods described in the last paragraph of the right-hand column of page 53, Parametric Methods, described in the first two paragraphs of the left-hand column of page 53, and Geometric Endmember Determination described from the third paragraph of the left-hand column of page 53 to the end of the left-hand column of page 54. In particular, the geometric endmember determination method described is "shrinkwrapping". A disadvantage of the shrinkwrapping technique is that all the data in the hyperplane must lie inside the simplex. See the last paragraph of the left-hand column of page 54 in which it states "shrinkwrapping is susceptible to outliers and artifacts that may adversely change of the shape of the simplex and hence, the estimate of the endmembers".

Keshava concedes that there are no known methods of combining parametric methods and geometric methods. In particular, page 53 left column paragraph 3 and page 53 right column paragraph 1 of Keshava describe a geometric interpretation of the linear mixture model underlying many endmember estimation methods (Reference [32]) but does not give any algorithm for estimating the endmembers based on using a term which is a measure of the size of the simplex. Reference 1331 provides an algorithm which finds the least volume simplex enclosing the data cloud. Neither of these references use a regularised least squares estimation method. The description of the Least Squares Method for finding the mixing proportions on pages 54 and 55 assumes that the endmembers are known or have been previously estimated. Thus Keshava describes endmember

determination as a first problem to be solved (as per pages 52-54 left column). Further Keshava describes inversion to find the mixing proportions (i.e. the abundance vector) to be a second distinct problem to be solved (as per pages 54 right column to 55). Neither of the endmember determination technique, nor the technique to find mixing proportions in Keshava teach or suggest repeating estimation (of the endmembers and the mixing proportions) steps until a stopping condition is reached. More importantly, none of the discussion or references in Keshava includes incorporating a measure of the size of the simplex into a least squares method to estimate the endmembers. In fact Keshava at p53 left column paragraph 2 last sentence states in relation to the parametric technique "successive estimates ...minimise the error in the fit and constraints ...are enforced between iterations". Such a minimizing process takes no account of the measure of the size of the simplex feature of claim 1. In other words it has no geometric factors. In fact the teaching of Keshava will result in the endmember positions being determined first, which fixes the size of the simplex. Thus it would not make sense to use this teaching, where the endmembers have been determined, to include a measure of the size of the simplex in the regularised residual sum of squares because the measure of the size of the simplex would thus be fixed. It is only when the endmembers and mixing proportions are iteratively estimated that the size of the simplex may change and thus including a measure of the size of the simplex has a use. This would not be foreseen by a person of ordinary skill in the art based on the teaching of Keshava.

The resulting contribution by the present invention is a method that modifies a parametric technique of minimizing a residual sum of squares by inclusion of a geometric term, in the form of the regularised residual sum of squares including a term which is a measure of the size of the simplex. This is a new technique that Keshava admits is not known, by virtue of the admission that there are no known technologies of combining parametric and geometric teachings. Consequently Keshava does not describe the subject matter of claim 1, nor would the subject matter of claim 1 be obvious in light of the disclosure of Keshava.

The rejection of dependent claims 5 and 6 as being obvious over Keshava is traversed for the same reasons stated above with respect to claim 1.

All claims are in good condition for allowance. If any small matter remains outstanding, the Examiner is requested to telephone applicants' attorney. Prompt reconsideration and allowance of this application is requested.

The Commissioner is hereby authorized to charge any deficiency, or credit any overpayment, in the fee(s) filed, or asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Account No. 14-1140.

Respectfully submitted,

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